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Notes on Physics

Charles W. Carman

Prefatory Note

In this outline a systematic course in physics has not been attempted. The aim has been, rather, to collect and assemble such material as would best serve the teacher who is laboring to introduce into the common schools observational work in physical science. Time, material, and quarters are often limited, yet much can be accomplished in narrow quarters and with extemporized apparatus. If one has a desire to know the truths of nature, enthusiasm and results will follow.

"What is so?" "If so, why?" These two questions embrace the whole inquiry of physical science. Let us make an earnest effort to learn what is so and why it is so. The student is cautioned not to use his memory too promiscuously. Do not memorize what follows in this outline. Please use, rather, as directed, your eyes, ears, nose, and mouth.

Directions to Students

There are many ways of studying physical science. We may begin by committing to memory facts and laws discovered by others, and by observing what is going on around us.

Another method, the one we shall follow, is to search in the laboratory and field for the truths we wish. But do not think that going to the laboratory and the field for a given length of time will bring about the desired end. This can be done only by following closely the directions given you, by using your senses freely, by careful thought, by much oral instruction, and by the assistance of many books.

The following general directions should be read carefully and kept in mind as a part of the special directions that are given you in the following pages:

Recitation Hour. — The recitation hour will be used: (1) to give you instructions regarding your work in the laboratory and in the field; (2) to question you on the work you have done previously; (3) to discuss the general principles of the subject, and (4) to sum up and review the previous work.

The Laboratory. — It is very important that you remember the laboratory is designed for the accommodation and preservation of the apparatus to be used, as well as to serve the purpose of a place in which to use it. The utmost care must be taken in moving and manipulating apparatus.

On entering the laboratory, take your place at the table assigned you. Read the directions given you as a guide in performing the exercise for which the apparatus before you has been arranged.

Diagram the apparatus used, if you are able to condense your records by doing so.

Record your manipulations, observations, and conclusions.

When the work assigned you has been completed, you may spend in the reference room the remainder of the time allotted.

Do not touch apparatus other than that designed for the work of the day. If a piece of apparatus is injured, inform your instructor at once. If you find you are unable to perform an exercise to your satisfaction, do not say to yourself (or to any one else), petulantly, "I can't," or "I do not understand it," but, after giving it careful thought, and making earnest effort, ask your instructor to assist you.

Note-Taking.—Make full notes, on a "scratch-pad," while in the laboratory. Let neatness, accuracy, and judgment be used in revising for your record-book. Let your work, sketches, and records be your own. Nothing will lower you in the estimation of your classmates and instructor more than the practice of petty dishonesty.

The Course in Physics

Leading Principles:

The subject-matter is the study of Nature and the Arts.

It is a study of anything and everything that is "going on" around us. For the lack of a better term, the name "Physics" (nature) has been given to the study of a certain class of natural phenomena.

A certain definite quantity of matter, set aside for the purpose of comparison with other quantities of matter, is a Standard Unit.

(See Carman's *Outline*, pp. 18 and 20, Lewis Institute edition.)

The study of nature embraces the study of physics, geology, astronomy, etc., and has done so from the earliest time; but the part of nature study designated physics, geology, astronomy, etc., has changed from decade to decade. If we study thoroughly the part of nature called geology, we must study physics, and vice versa.

(See Carman's *Outline*, pp. 42–48.)

The subject of physics is largely the subject of measurements. To make measurements of any considerable value, preliminary training is necessary.

Subject-Matter.

The "Physics" Side of Nature Study.

The Barometer.

References: Carman, *Outline of an Elementary Course in Physics*, p. 52; Stewart and Gee, *Elementary Practical Physics*, Exercises 7-11; Chute, *Physical Laboratory Manual*, pp. 14-15; Davis, *Elementary Meteorology*, p. 11; Adams, *Physical Laboratory Manual*, pp. 27 and 59; Edser, *Measurements and Weighing*, pp. 41-45; *Chicago High School Manual*, p. 4.

Exercise 1.—(Math.) Give the Theory of the Vernier.

Exercise 2.—Read the Fortin Barometer, using the Vernier attached to the Scale.

Exercise 3.—(Math.) Construct a Vernier.

See Carman's *Outlines*, p. 58, Exercise 2 (a).

Exercise 4.—Repeat Torricelli's "Classic Experiment." See Chute's *Laboratory Manual*, pp. 60-62; Adams' *Manual*, p. 57; *Chicago High School Manual*, pp. 84-89.

Exercise 5.—(a) Take the aneroid barometer furnished you to the basement of the Institute building and make and record three readings. Read the Fahrenheit thermometer also. Go to the third story of the building and repeat.

Determine the height of the building by using the following formula: Let

P=air pressure at lower place of reading,
p=air pressure at upper place of reading,
t=temperature Fahr.,
h=vertical distance in feet between places of reading; then

$$h=\left\{60360+(t--32^\circ)\ 122.68\right\}\log._{10}\frac{P}{p}$$

Note.—Ask your instructor in mathematics to discuss this application of mathematics to physics.

Exercise 5.—(b) (Optional.) Take the aneroid barometer and a thermometer to Lincoln Park and repeat (a) at the base and highest point on the high bridge. Compute the height.

Exercise 5.—(c) (Optional.) Determine the height of a neighboring water-tower by means of similar readings.

Exercise 5.—(d) (Optional.) A trip on the Ferris Wheel. With the apparatus used above, make readings on entering the car. Make readings at intervals of thirty seconds during the trip. Plot a curve from readings obtained.

See Carman's *Outline*, pp. 68-76.

Ask your instructor in mathematics to aid you if you need assistance.

Compute the height of the wheel from your maximum and minimum readings.

Ask your instructor in mathematics to give you other methods of computing the heights of the building, bridge, water-tower, and wheel.

Exercise 6.—Read and record the barometer and thermometer three times each day for a period of three weeks. Make the readings as early as convenient in the morning, at noon, and as late as convenient in the afternoon or evening.

Plot a curve from the readings obtained.

Record, also, the amount and kind of clouds, and the direction of the wind.

Special—Section I—References.

Carman's *Outline*, 1889 Ed.—Page 28, Exercises 1 and 2. Page 29, Exercises 5, 7, 8, 9, and 10. Page 30, Exercises 11 and 13. Page 31, Exercises 14 and 20. Page 32, Exercises 24 and 25. Page 33, Exercises 37 and 39.

Note.—The exercises given above are to be performed in the laboratory and recorded in your record-book.

Special—Section II—References.

Carman's *Outline*, Lewis Institute Ed. —Page 18, Standard Units. Page 20, Table of Relative Values. Page 22, Mathematical Formulas. Page 24, Alphabetical Tables of Definitions. Page 26, The C. G. S. System of Units. Page 40, The Greek Alphabet. Page 42, Lecture Notes. Page 48, Laboratory.

Demonstrate "The General Theory of the Diagonal Scale." Page 50, Exercise 1 (a) and (c). Page 52, Demonstrate "The General Theory of the Vernier." Page 58, Exercise 2 (a), (b), (c), and (d).

Nature Study—Section III—References.

Carman's *Outline*, 1889 Ed.—Pages 86 and 87.

Carman's *Outline*, Lewis Institute Ed. —Page 124, Lecture Notes. Page 126, Laboratory: Exercise 15 (a) and (b). Page 126, Questions.

(See Chicago Institute COURSE OF STUDY, Vol. I, No. 2, October, page 130.)

Sections I, II, III

Tuesdays—12:15 to 1:00.

References: Carman's *Outlines*, 1889 Ed., pp. 86–87; same, 1897 Ed., p. 126; Waldo, *Elementary Meteorology;* Davis, *Elementary Meteorology;* Buchan, *Introduction to Meteorology;* Scott, *Elementary Meteorology;* Russell, *Meteorology;* Greely, *American Weather;* Appleton's Cyclopedia, Vol. XI, p. 432; same, 1875, p. 797; same, 1896, p. 470; same, 1898, p. 489; daily weather map.

The study of a daily weather map.

The study of the official weather forecast as published in the daily papers.

The location of, and the method of reading, the meteorological instruments of the Chicago Institute.

A visit to the local station of the United States Weather Bureau, Auditorium Tower. Read the barometer at the base of the tower and at the highest point that you are able to reach. Compute the height of the tower. (See *The Aneroid Barometer; Its Construction and Use*, Van Nashand's Science Series, pp. 88, 107 and 121.)

The preparation of five weather maps.

Subjects for experimental recitations:

1. Historical Sketch of the Growth of the Science.
2. The Mercurial Barometer.
3. Barographs.
4. Aneroid Barometers.

5. Thermometers and Thermographs.

6. Hygrometers, Psychrometers, and Rain Gauges.

7. Kites and Meteorological Observations.

8. Dew, Fog, Mist, Cloud, Rain, Snow, and Hail.

9. Electrical Phenomena.

10. Optical Phenomena.

11. How Weather Maps are Made.

Kindergarten Pedagogy

Bertha Payne

During the spring quarter we will take up the adaptation of subject-matter to the children of the two grades found in the kindergarten. This will include a consideration of the corresponding growth in expression seen in the children of three, four, and five years, respectively.

The question is frequently asked, When is a child ready to enter the first year of school? or, When has he gained all the kindergarten has to offer? These questions are often answered by saying that the kindergarten affords opportunities to learn and to gain power through play. When the children are ready to work, the school is the proper place. This is rather a misleading distinction, for work goes on in the kindergarten, and play in the school, and rightly so.

If we analyze the question more closely, we find the children developing new needs and new interests that may be classified as follows:

1. The need is felt for preserving a record of his doings, his ideas, his experiences, in symbols; writing follows.

2. Playing at participation in the work of others becomes less satisfying than formerly. The child feels need of an effective part in his little society.

3. In order to reach some goal, the child becomes capable of planning a process in which the end is not immediately achieved, but requires time and forethought.

4. The casual interest begins to show itself strongly. The attention long called out by motion and life is turned more definitely to search for causes in the physical world. The genuine experiment in nature study has its place here.

All these changes mark the need of the reading and writing, the more continuous work, and the scientific treatment of common experiences which the school supplies.

Before this time comes, however, when a child is still in the kindergarten, he shows different stages quite as marked in their characteristics.

In infancy, as in childhood and in all periods, all have in common a want; the want leads to action.

I. Desire is at first merely for movement.

II. This movement so set up brings consciousness of power: desire to move in certain particular and controlled ways, cooing, lifting head, turning to light, etc.

III. Desire to reproduce certain sensational results, first accidentally experienced: grasping, reaching, throwing, rattling, pounding.

IV. Following the first ideo-motor imitations comes desire to reproduce the actions of others, to use objects as others use them. Repetition follows success. Love of feeling power is thus satisfied.

V. True play-desires appear. New uses are invented for objects, the meaning of one thing is applied to something else. The hat is a cradle, the cookie a wheel, the stick is a horse, and the corn-cob a doll. When this play no longer suffices with but one companion, the kindergarten affords the little society and the tools for more extended plays.

Motive: Expansion of self to take in the meaning and animus of people and things.

VI. Play impulses merge into something more like work. The accident of resemblance